Events Leading to Failure of B17 Spool

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Vacuum Leak @ B11 Separators

- After Nov 16 access, found vacuum ~ 10^{-5} torr @ B11 seps
  - 2 horz + 1 vert separators @ B11 (30 ft warm section)
  - Techs removed leaky RGA head on horz separator
  - Fired separator sublimation pumps & conditioned separators
- After repair, separator vacuum still higher than normal
  - High 10^{-9} torr - would like few 10^{-10} torr
  - Vacuum fine with isolation valves closed ⇒ no separator leak
  - Problem caused by gas desorbing from nearby cold beam pipe
    - Air adsorbed/froze onto pipe during the separator RGA leak
- Vacuum improving slowly with beam → keep running
  - Otherwise, warm up B1 to 80 K
  - Higher risk of separator sparks with worse vacuum
  - Store 4506 OK for 15.5 hr; Store 4508 – B11 Horz #1 spark 6.5 hr
  - Store 4514 OK for 26.5 hr; Store 4515 – B11 Horz #1 spark 8.0 hr

Quenches from B11 Horz Separator Spark

- In general, sparks cause ~few mm orbit distortion in arcs in 1 turn
  - Beams get driven into their respective collimators, quench nearby
  - Store 4508 – quench @ D4, E1, F4
  - Store 4515 – quench @ F4, C4, E1, D1, A4, B1, B3

- What happened in store 4515? *(Analysis still in progress)*
  - Pbars kicked into F49/F48 collimators in 1 turn
    - F48L very fast quench – too fast for 1 kHz fast quench abort system
    - F48U fast quench detected 2 ms later, pulled the abort
  - Protons not lost in 1 turn – kept circulating until abort kickers fired?
    - Orbit distorted even more by quench of F48L?
    - Led to higher losses at CDF and D0
  - B15 quench was rather slow compared to initial quenches
    - Beam did not directly strike the B17 spool
  - B17 spool failure just mechanical rupture from pressure spike
    - Could have failed during any B1 quench?

Outcome

- B11 horz separator #1 spark led to end of store 4515
- Pbars driven into F49/F48 collimators and caused a fast quench
  - Initial quench too fast even for 1 kHz fast quench detection
- Protons circulated with big orbit distortion until abort kickers fired?

- B17 spool piece suffered mechanical failure as a result of quench-induced pressure spike, not a direct hit from beam

- Don't run with degraded separator vacuum due to higher spark risk
  - In similar situation, warm up to desorb gas from beam pipe
- Continue pushing improvements of Tevatron abort system
  - Unmask BLMs for HEP stores? (Concern about false aborts)
    - This was first instance since implementing fast quench aborts that BLM abort would have helped
  - Improved BLM electronics already in progress